7

VII. SETTLEMENT FORMULA DEVELOPMENT

A. Introduction

This section describes 2002 Study development methods for the following average schedule settlement formulas:

- Common Line Access Line
- Universal Service Support Contribution Reimbursement
- Central Office
- Intertoll Dial Switching
- Line Haul Distance Sensitive
- Line Haul Non-Distance Sensitive
- Special Access
- Signaling System 7 (SS7)
- Rate of Return Factors
- Equal Access Implementation

Development of these settlement formulas is described in Sections VII.B through W.M. Impacts of the proposed settlement formulas are described in Section VII.N. The proposed formulas are displayed in Section VIII, where they are contrasted with current formulas.

Each year NECA analyzes relationships between access cost and access demand and proposes formula revisions, where necessary, to reflect changes in these relationships. Settlement formulas can be revised for several reasons, such as:

- FCC rule changes
- Cost and demand growth
- Technology changes
- Network structure changes
- Tariff changes

B. Outlier Analvsis

For each formula that uses sample data from average schedule study areas, outlier analysis was performed. Most settlement formulas are developed either by linear regression or ratio estimates, which use outlier accommodation methods described in Section IV.C. The Common Line Access Line and Non-Distance Sensitive formulas are non-linear models which require an additional step to develop the DFFITS statistic required by the outlier accommodation method.

C. Common Line Access Line Formula

Common Line formulas include the Common Line Access Line formula (described here in Section VII.C), the Universal Service Contribution formula (Section VII.D), the Common Line Line Port and Common Line Transport formulas (Section VII.M), and the Common Line Rate of Return Factor formula (Section VII.K).

The Common Line Access Line formula is designed to compensate average schedule companies for interstate costs associated with subscriber access lines (*e.g.*, cable, drop, protector and circuit equipment). Relative costs of much of the equipment and the associated expenses are usually higher in lower density exchange areas. To reflect this relationship, the formula relates the Common Line revenue requirement per access line to access lines per exchange. Access lines used in the development of this formula were projected to the test period as described in Section V. Derivation of the Common Line revenue requirement is explained in Section VI.F.

The Common Line Access Line settlement formula was developed using the same line and curve structure underlying the current formula. This formula recognizes relationships between relative cost and lines per exchange for all companies. The formula has four parts: a sloping line for small study areas with relatively low average access lines per exchange; a downward sloping curve for midrange values of access lines per exchange between 513 and 10,000 lines per exchange; a transitional sloping line connecting the midrange curve to the curve for larger study areas with lines per exchange between 10,000 and 15,000; and another downward sloping curve for lines per exchange greater than or equal to 15,000.

The Common Line Access Line formula relates common line cost per line (CPL) to the study area's access lines per exchange (LPE). This model has the following parameters:

- Three lines per exchange breakpoints which are the small company lines per exchange limit (K_1), the midrange lines per exchange limit (K_2), and the large company lines per exchange limit (K_3). The latter two limits were determined by graphical analysis to be 10,000 and 15,000 respectively. The small company limit was resolved by regression methods.

- A slope (b_1) and intercept (a_1) of the small company line, both of which are solved by regression methods.

- A slope (b_2) and intercept (a_2) **of** the midrange curve, of which the slope is resolved by regression methods, while the intercept is resolved by a constraint that requires that the small company line meet the midrange curve at K_1.

- A High Lines per Exchange Multiplier (M) for the large company curve, which is resolved by regression methods.

- The intercept and slope of the transitional line, both **of** which are resolved by constraints that the transitional line meet the midrange and large company curves at K_2 and K_3 respectively.

First, NECA analyzed graphically the Common Line Access Line revenue requirements of study areas with higher lines per exchange. Study areas with lines per exchange below 10,000 had relatively higher revenue requirements per line. Study areas with lines per exchange greater than 15,000 had relatively lower revenue requirements per line. There was no conclusive trend of revenue requirement per line for study areas between 10,000 and **15,000** lines per exchange. Therefore, **NECA** continues the use of 10,000 and 15,000 lines per exchange as the limits K_2 and K_3 respectively.

Second, a non-linear regression solution was derived for K_1. This model was structured as one sloping line meeting a downward sloping curve at a small company breakpoint. The best-fitting small company breakpoint derived by this method was 5 13 lines per exchange.

The large company curve is proportionately reduced from the midrange curve using the High Lines Per Exchange Multiplier M. This multiplier accounts for the lower cost per line of the large lines per exchange study areas, producing a better model fit.

The best-fitting combination of parameters a_1, b_1, b_2, and M were solved using a weighted non-linear regression program, derived as follows:

For companies with LPE < 513,

$$CPL_i = a_1 + b_1 \times LPE_i$$

For companies with 513 <= LPE < 10,000,

$$CPL_i = a_2 + b_2 / LPE_i$$

For companies with 10,000 <= LPE < 15,000,

$$CPL_i = P_i \times (a_2 + b_2 / 10{,}000) + (1 - P_i) \times M \times (a_2 + b_2 / 15{,}000)$$

$$P_i = \frac{15{,}000 - LPE_i}{15{,}000 - 10{,}000}$$

For companies with 15,000 <= LPE,

$$CPL_i = M \times (a_2 + b_2 / LPE_i)$$

The following indicator variables are needed to program this model.

$\delta_{1i} = 1$ if $LPE_i < 513$; otherwise $\delta_{1i} = 0$.
$\delta_{2i} = 1$ if $513 <= LPE_i < 10{,}000$; otherwise $\delta_{2i} = 0$.
$\delta_{3i} = 1$ if $10{,}000 <= LPE_i < 15{,}000$; otherwise $\delta_{3i} = 0$.
$\delta_{4i} = 1$ if $15{,}000 <= LPE_i$; otherwise $\delta_{4i} = 0$.

Then the model is written as:

$$CPL_i = \delta_{1i} (a_1 + b_1 \times LPE_i) + \delta_{2i} (a_2 + b_2 / LPE_i) + \delta_{4i} \times M \times (a_2 + b_2 / LPE_i) \\ + P_i \times \delta_{3i} \times (a_2 + b_2 / 10{,}000) + (1 - P_i) \times \delta_{3i} \times M \times (a_2 + b_2 / 15{,}000)$$

This model has the linear constraint that:

$$a_1 + b_1 \times 513 = a_2 + b_2 / 513$$

Consequently,

$$a_2 = a_1 + (b_1 \times 513) - (b_2 / 513)$$

Therefore, regression model parameters are reduced to a_1, b_1, b_2, and M.

Collecting model terms as factors of parameters yields the following model expression:

$$CPL_i = a_1 \times (A1_i + M \times A2_i) + b_1 \times (B1_i + M \times B2_i) + b_2 \times (C1_i + M \times C2_i)$$

where,

$$A1_i = \delta_{1i} + \delta_{2i} + \delta_{3i} \times P_i$$
$$A2_i = \delta_{3i} \times (1 - P_i) + \delta_{4i}$$
$$B1_i = \delta_{1i} \times LPE_i + 513 \times (\delta_{2i} + \delta_{3i} \times P_i)$$
$$B2_i = 513 \times [\delta_{3i} \times (1 - P_i) + \delta_{4i}]$$

$$C1_i = \left(-\frac{1}{513}\right) \times (\delta_{2i} + \delta_{3i} \times P_i) + \frac{\delta_{2i}}{LPE_i} + \frac{P_i \times \delta_{3i}}{10{,}000}$$

$$C2_i = \left(-\frac{1}{513}\right) \times [\delta_{3i} \times (1 - P_i) + \delta_{4i}] + \frac{\delta_{3i} \times (1 - P_i)}{15{,}000} + \frac{\delta_{4i}}{LPE_i}$$

Using the variables CPL_i, $A1_i$, $A2_i$, $B1_i$, $B2_i$, $C1_i$, and $C2_i$, the program NLIN (NonLINear regression)[1] solves for parameters a_1, b_1, b_2, and M that best fit the data.

The resulting line and curve model produces a stable, continuous settlement formula and had an ***R-Square*** statistic of **0.29, a** ***t-statistic*** of **13.78** for a_1, a ***t-statistic*** of **3.50** for b_1, a ***t-statistic*** of ***3.23*** ***for*** b_2, and a ***t-statistic*** of ***5.52*** for M. The proposed formula is shown in Section VIII.

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1 SAS Institute Inc., ***SAS/STAT® User's Guide, Version 6***, 1,135 (4th ed. **SAS** Institute Inc., **1990).**

D. <u>Common Line Universal Service Contribution Reimbursement Formula</u>

NECA proposes to continue the settlement method which became effective on January 1, 1998, to compensate average schedule companies for their interstate access costs **of** contributions to the new universal service fund. Under section 54.706 of the Commission's rules, all communications companies, including average schedule companies, are required to contribute to the new universal service funds?

The Universal Service Order' directs carriers to assign all contributions to federal universal service programs to the interstate jurisdiction, and prescribes that the appropriate contribution costs (based on revenues from regulated services) borne by ECs not subject to federal price caps be assigned to their common line revenue requirement. Accordingly, cost companies will assign these costs to the interstate jurisdiction in their cost separations studies, and will recover these costs from end user charges!

In the December 1997 Filing: NECA proposed that the same principles apply to average schedule companies and filed a common line universal service contribution settlement formula equal to the portion of the contribution paid that is associated with the regulated revenues of the average schedule

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2 Under section 54.708 of the Commission's rules, there is an exemption **for** companies whose contribution would be ***de minimus***.

3 Federal-State Joint Board on Universal Service, CC Docket No. 96-45, ***Report and Order,*** 12 FCC Rcd 8776 (1997).

4 **MAG** Order at ¶ 177.

5 National Exchange Carrier Association, Inc. Proposed Modifications to the 1998-99 Interstate Average Schedule Formulas, AAD 98-20, ***Order,*** 13 FCC Rcd 17351 (1998).

company. This amount is assigned to the common line revenue requirement according to Commission rules. The Commission approved this method in a 1998 order,[6] and in each subsequent year.

The rules regarding Universal Service Contributions have changed from year to year. Consequently, NECA does not have a history consistent with next year's contributions from which to develop an accurate formula based on demand **or** revenue variables. Therefore, NECA proposes to continue the current structure, which compensates for actual universal service contributions made by carriers.

E. Central Office (CO) Formula

The Central Office (CO) formula is designed to compensate average schedule companies for the local switching costs of interstate access calls, and for the cost of interstate carrier access billing systems (CABS). The cost of providing these functions has been found to depend on total switched interstate access minutes, access lines, number of exchanges served, and relative access minutes per access line.

The proposed structure is identical to that of the current CO formula and includes a basic settlement per minute and per exchange formula, an access line factor, and a settlement per study area for the component of CABS billing cost which is independent of the count of exchanges and access minutes. The basic formula consists of **an** exchange component, three **per** minute components corresponding to three tiers of minutes per line, and a high volume access line multiplier. The multiplier produces a better relationship between access line size and the cost of serving study areas with high traffic volumes of minutes per line.

6 ***June 1998 Order.***

In previous studies, **NECA** analyzed detailed engineering data to determine switching equipment requirements to serve high traffic volumes. The proposed formula structure continues to reflect the findings of these analyses.

The ***CO*** formula has the following parameters:

- **A** coefficient of the exchange variable (b) and of the normal volume minute variable (a_1)

- **A** breakpoint in the access line factor model (K) where the sloping line for companies with smaller access line counts meets the horizontal line for study areas with larger access line counts. This breakpoint was chosen to be 10,000, which is the upper limit of the group that has the largest DEM weight according to Commission rules?

- The intercept of the large company access line factor line (w), which, by design, is equal to 10

- Slope (v) and intercept (u) of the small company access line factor (ALF) component. The slope is resolved by regression, while the intercept is determined by the constraint that the small company ALF line and the large company ALF line meet at K. Thus, $u = 1 - 10{,}000v$.

- The high volume access line multiplier (M) which was resolved iteratively, as the one

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7 47 C.F.R. § 36.125(f).

which fit the high volume data best

- Coefficients of high volume minutes (a_2 and a_3) which were resolved by ratio calculations

- Coefficient **(d)** of exchange counts, (e) of normal volume access minutes, and an intercept (c) of the CABS cost model. These coefficients were determined using cost company data.

1. <u>Formula Based on Carrier Access Billing System (CABS) Costs in Cost Studies</u>

Each average schedule company incurs monthly costs to render access bills to Interexchange Carriers. The Carrier **Access** Billing System (CABS) cost components of the CO settlement formula are designed to compensate average schedule companies for the interstate portion **of** these costs. Development of the CABS formula consisted of calculating cost study CABS revenue requirements, followed by regression modeling. This analysis used sample cost company exchange counts and **2000** cost studies.

Average schedule companies do not separately account for CABS costs. Rather, according to Class B accounting practices, these costs are included with many other costs in Account **6620,** Services Expenses. Consequently, a focused analysis of CABS costs incurred by average schedule companies would not be practical.

On the other hand, according to separations methods prescribed in section **36.381** of the Commission's rules, CABS cost data were reported explicitly in cost studies. These data provided a suitable basis for analysis **of** average schedule CABS costs. Factors that determine CABS costs include the number of interexchange carriers billed, the number of exchanges served, the number of separate Special Access services and service orders billed, and the complexity of meet point arrangements. NECA's review of CABS documents supplied by sample average schedule and cost companies indicated similar distributions of these factors in the **two** groups. Consequently, NECA concluded that CABS costs from sample cost study areas would adequately represent average schedule CABS costs.

The CABS revenue requirement was calculated in **two** steps. First, 2000 sample cost study accounts were forecasted to the test period using the stratified composite account growth rates derived in Section V.B.5. These accounts are displayed in Appendix B1. Second, each sample cost study area's projected interstate CABS revenue requirement was determined using the method shown in Exhibit **7.1.**

NECA developed **a** model using the number of exchanges and the number of normal volume switched access minutes **as** the independent variables. The proposed CABS formula resulting from the regression model follows. This formula provides coefficients ***c, d,*** and ***e*** of the CO formula.

CABS Cost =

$$2{,}909.42 + (385.25 \times \text{Number of Exchanges}) + (0.000558 \times \text{Number of Minutes})$$

R^2 = 0.18	t-statistic (Exchanges)	= 5.68	F-statistic = 26.53
	t-statistic (Minutes)	= 2.66	
	t-statistic (Intercept)	= 5.50	

EXHIBIT 7.1

ILLUSTRATIVE CALCULATION OF CABS REVENUE REQUIREMENT USING WEIGHTED SUMMED AMOUNTS FROM COST SEPARATIONS STUDIES (IN THOUSANDS)

	Services Expense Category 2 (Revenue Accounting)	
A.	Unseparated CABS Expense	$46,663
B.	Interstate CABS Expense	$23,362
	Interstate Indirect Costs Calculation	
	Depreciation & Amortization Expense	$354,145
	Tax Expense	$45,834
	General & Administrative Expense	$158,273
	Executive & Planning Expense	$72.295
C.	Total Interstate Indirect Costs	$630,547
	Unseparated Indirect Costs Calculation	
	Depreciation & Amortization Expense	$1,039,552
	Tax Expense	$134,542
	General & Administrative Expense	$454,525
	Executive & Planning Expense	$220,226
D.	Total Unseparated Indirect Costs	$1,848,845
E.	Total Unseparated Expenses	$3,451,800
F.	Unseparated Expense Less Unseparated Indirect Costs (Line E - Line D)	$1,602,955
G.	CABS Indirect Costs Fraction (Line A/Line F)	0.029111
H.	Interstate CABS Indirect Costs (Line G x Line C)	$18,356
I.	Total Interstate CABS Cost (Line B + Line H)	$41,718

2. Studies of Average Schedule Company Data

NECA also conducted the following studies of average schedule data, described in Sections VII.E.2.a through VII.E.2.e, to determine CO settlement formula coefficients. In particular, these studies support the continued use of a rate per exchange, a rate for access minutes in the normal traffic volume range, lower rates for access minutes in high traffic volume ranges, and an access line factor. CO revenue requirements of average schedule study areas, described in Sections VI.F through VI.H, were used to develop such settlement rates to fit those data most accurately.

The following methods were used to update settlement rates in the current formula structure in order to refine rates for high traffic volumes.

a. Preliminary Access Line Factor Formula

A baseline cost per minute was computed to equal the average monthly CO revenue requirement per minute among average schedule study areas having more than 10,000 access lines.

$$\textit{Baseline Cost Per Minute} = \frac{\sum \textit{(Sample Weight} \times \textit{Monthly Central Office Revenue Requirement} \times \textit{Variance Weight)}}{\sum \textit{(Sample Weight} \times \textit{Access Minutes} \times \textit{Variance Weight)}}$$

where the summations are taken over sample study areas with more than 10,000 access lines. This calculation produced a baseline cost per minute equal to 0.026524.

For each sample study area, an access line factor ratio was computed as follows:

$$\textit{Access Line Factor Ratio}_i = \frac{\textit{Central Office Revenue Requirement Per Minute}}{\textit{Baseline Cost Per Minute}}$$

where i corresponds to the ith sample average schedule study area.

NECA used standard constrained linear regression methods to develop a model that related the Access Line Factor Ratio to access lines. Outliers were identified and accommodated as described in Section IV.C. This Preliminary Access Line Factor Model had the following structure:

$$\begin{aligned}
&\textit{For Study Areas with Access Lines Less Than 10,000:}\\
&\qquad \textit{Access Line Factor} = 1.893915 - 0.000089392 \times \textit{Access Lines}\\
&\textit{For Study Areas with Access Lines Greater Than or Equal to 10,000:}\\
&\qquad \textit{Access Line Factor} = 1.0\\
&R^2 = 0.54 \quad F\text{-}statistic = 189.19 \quad t-statistic\ (\textit{Access Lines}) = -13.75
\end{aligned}$$

An adjustment to the coefficients of this model is shown later in Section VII.E.2.c, which produces coefficients u and v of the central office formula.

h. Basic Cost Per Minute Formula

Using the Preliminary Access Line Factor Model, NECA calculated a Model Access Line Factor value for each sample average schedule study area. A Basic Cost Per

Minute was then calculated for each sample average schedule study area.

$$\text{Basic Cost per Minute}_i = \frac{\text{Monthly Central Office Revenue Requirement Per Minute}_i}{\text{Model Access Line Factor}_i}$$

where *i* corresponds to the ***ith*** sample average schedule study area.

Using standard linear regression methods, NECA developed a model relating Basic Cost Per Minute to the ratio of Exchanges Per Access Minute. Only those study areas with minutes per line less than 350 were used to develop the Basic Cost Per Minute model. The following model resulted.

$$\text{Basic Cost Per Minute} = 0.024520 + \left(498.76 \times \frac{\text{Exchanges}}{\text{Access Minutes}}\right)$$

$$R^2 = 0.11 \qquad t-\text{statistic (Intercept)} = 23.50$$

$$F-\text{Statistic} = 19.69 \qquad t-\text{statistic (Exchanges / Access Minutes)} = 4.44$$

Alternatively, after multiplying this formula **by** Access Minutes,

$$\text{Basic CO Cost} = 0.024520 \times \text{Access Minutes} + 498.76 \times \text{Exchanges}$$

This model provides coefficients a_1 and b of the central office formula.

C <u>Folding CABS Cost into the Central Office Formula</u>

Coefficients of the Cost Company CABS cost formula, derived in Section VII.E.1, and the Basic Cost Per Minute formula were then combined. This task was performed algebraically, as follows, ensuring that the combined formula produced settlements equal to total settlements from the separate formulas.

CABS Cost Formula $= d \times E + e \times Min + c$

Initial Central Office Formula (Prior to Folding-in CABS)

$$= (\text{Basic CO Cost}) \times (\text{Preliminary Access Line Factor Model})$$

$$= (a_1 \times Min + b \times E) \times [(u_o + v_o \times L) \times I + (1 - I)]$$

where:

E	=	Number of Exchanges
L	=	Number of Access Lines
Min	=	Number of Monthly Normal Volume Access Minutes
I	=	1, if Access Lines < 10,000
	=	0, if Access Lines > 10,000

Intermediate Central Office Formula (After Folding-in CABS)

$$= (\text{Adjusted Basic CO Cost}) \times (\text{Final Access Line Factor}) + \text{CABS Study Area Factor}$$

$$= [(a_1 + e) \times Min + (b + d) \times E)] \times [(u + v \times L) \times I + (1 - I)] + c$$

where:

u and **v** are constrained by the relation: $u = 1 - 10{,}000v$

NECA calculated coefficients u and **v** such that:

$$\sum (\text{Central Office Formula Prior to Folding in CABS} + \text{CABS Cost Formula}) = \sum (\text{Central Office Formula After Folding in CABS}),$$

where the summation is over the 451 average schedule study areas in the Traffic Sensitive Pool with normal volume minutes only. Data of these study areas, together with eighteen study areas with high volume minutes, and thirty-seven study areas not in the Traffic Sensitive Pool, are shown in Appendix E.

Solving this equation for the Final Access Line Factor Coefficients yielded the following values: u = 1.805977 and v = -0.000080598.

Coefficients of the Initial ***CO*** formula and Intermediate formula are given in Exhibit 7.2.

EXHIBIT 7.2

CENTRAL OFFICE FORMULA COEFFICIENTS

	Initial (Before Combining *CABS*)	**Intermediate (After Combining *CABS*)**
Per Access Minute	0.024520	0.025078
Per Exchange	498.76	884.01
Access Line Factor Intercept	1.893915	1.805977
Access Line Factor Per-Line Coefficient	-0.000089392	-0.000080598
Per Study Area	0.0	2,909.42

The CO formula derived in subsections *a* **through** *c* provides an unbiased method of calculating settlements for the total population of average schedule study areas with normal traffic volumes. Subsequent methods to refine the CO formula for high traffic volumes are designed to produce a lower set of settlement rates for higher traffic volumes, as described in the next two subsections.

d. <u>The High Volume Access Line Multiplier</u>

The High Volume Access Line Multiplier helps produce settlements for high traffic volumes with equivalent accuracy between all access line size ranges. NECA updated the coefficient of the High Volume Access Line Multiplier, using high traffic volume average schedule study area CO revenue requirement and demand data described in Section III.F.

NECA's tests show that without the High Volume Access Line Multiplier, average schedule study areas with high traffic volumes and low access line counts would tend to receive settlements slightly below their modeled revenue requirements, while study areas with high traffic volumes and higher access line counts would tend to receive settlements above their revenue requirements. The High Volume Access Line Multiplier corrects this condition by causing the effective settlement rate to decrease as access lines increase. NECA continued to use the following structure for the High Volume Access Line Multiplier, as it had in prior Filings since 1995.

If Access Minutes per line > 350 then

High Volume Access Line Multiplier = M / (Access Lines)

Else

High Volume Access Line Multiplier = 1.0

The coefficient of the High Volume Access Line Multiplier **was** chosen by an iterative method described in the following section.

e. Settlement Rates for High Traffic Volumes

This development used the revenue requirements described in Section VI.J and demand data described in Section III.F.

The portion of the proposed basic CO settlement formula applicable to high volume access minutes uses five parameters: two high traffic volume thresholds, two high traffic volume per minute settlement rates, and the numerator of the High Volume Access Line Multiplier. Because the number of high traffic volume study areas is small and because the relationship between parameters is intrinsically non-linear, traditional least squares regression methods are not sufficient to solve for these parameters.

The iterative method repeats the calculation of model parameters once for each of many possible combinations of model parameter values. The accuracy of fit of the model to the data is evaluated for each of these iterations using a test statistic called the Mean Relative Absolute Deviation defined below. The set of coefficients that produced the most accurate model was chosen.

In these iterations, NECA employed the following logic in setting the constraints. First, settlement rates are required to decrease monotonically as traffic volumes increase. Second, settlement rates should differ meaningfully from tier to tier (10% or more). Tiers with settlement rates that do not differ meaningfully were to be combined.

NECA defined the parameters for each iteration as follows. Trial values were chosen for each of the two high volume minutes per line thresholds, and for the numerator of the High Volume Access Line Multiplier (HVALM).

For each iteration, NECA tested for consistency with the logical criteria and for the fit of the resulting CO settlement formula to the CO revenue requirements of the full set of high traffic volume study areas. NECA identified iterations that met the constraints described and fit the data most accurately.

The steps of this iterative process are detailed in Exhibit **7.3.** These steps use the High Traffic Volume Revenue Requirement (HTVRR) developed in Section VLJ. For the following calculations, the per study area term of the Intermediate ***CO*** formula was not used, because it represents a cost of CABS billing, not a cost of Local Switching.

Tier 1 Settlements =	Intermediate ***CO*** settlements for access minutes in the Normal traffic volume tier
Tier 2 Settlements =	High Traffic Volume settlements for access minutes in the first high traffic volume tier

EXHIBIT 7.3 **ITERATIVE PROCESS FOR DETERMINING** **HIGH TRAFFIC VOLUME COEFFICIENTS**
1. Choose a numerator for the High Volume Access Line Multiplier, between 400 and 1,000.
2. Choose a lower limit (K_2) for the highest high traffic volume tier (Band **3).**
3. Choose a lower limit (K_1) for the middle **high** traffic volume tier (Band 2), between 350 **and** K_2.
For each study area in the Band 2: **4.** Calculate the Tier 1 Settlement 5. Calculate the Tier 2 Residual = HTVRR – Tier 1 Settlement *6.* Calculate the Basic Tier 2 Revenue Requirement = Tier 2 Residual / (ALF x HVALM) Using total data from all study areas in Band 2: 7. Calculate the Tier 2 Settlement Rate = $\frac{\text{Basic Tier 2 Revenue Requirement}}{\text{Tier 2 Access Minutes}}$
For each study area in Band **3:** 8. Calculate the Tier 1 and Tier 2 Settlement *9.* Calculate the Tier **3** Residual = HTVRR – Tier **1** Settlement – Tier 2 Settlement 10. Calculate the Basic Tier **3** Revenue Requirement = Tier **3** Residual / (ALF x HVALM) Using total data from all study areas in Band **3:** 11. Calculate the Tier **3** Settlement Rate = $\frac{\text{Basic Tier 3 Revenue Requirement}}{\text{Tier 3 Access Minutes}}$
Over all High Traffic Volume Study **Areas:** 12. Calculate the Mean Relative Absolute Deviation

Each study area is assigned to a band. Study areas in Band 1 are those with normal traffic volumes. Band 2 includes study areas with traffic volumes exceeding K_1, but less than K_2. Band **3** includes study areas with traffic volumes exceeding K_2.

NECA chose the iteration which produced the best fit and met all the constraints. Several other combinations either did not meet constraints, or did not fit the data as well. The resulting coefficients are shown in Section VIII.

The test for fit of this model to the data was performed using a Mean Relative Absolute Deviation test, rather than the more common ***R-Square*** test. The Mean Relative Absolute Deviation Test was used because only a small number of data points were available, and because the large and non-symmetric variation in study area sizes violated the assumption of normality and homogeneity of error variances required to use an ***R-Square*** statistic.

Statistical literature recommends use of robust methods rather than least squares when the assumption of normality or homogeneity of error variance is **violated.**[8]

The following is the calculation method for this statistic:

$$\textit{Mean Relative Absolute Deviation} = \frac{\sum_{i} \frac{|\textit{Deviation Of Model From Revenue Requirement}_i|}{\textit{Revenue Requirement}_i}}{N}$$

[8] ***See, e.g.,*** Raymond H. Myers, ***Classical and Modern Regression with Applications,*** Chapter ***7*** (2nd ed.,1990) for a description of the use of absolute deviation optimization methods in place of an R-Square optimization method.

where the summation is over the high traffic volume study areas. The Mean Relative Absolute Deviation of the proposed high traffic volume formula is 0.60.

This CO formula has been shown neither to disadvantage nor to favor high traffic volume study areas. It produces settlements approximately equal to their Central Office revenue requirement in the aggregate. This proposed CO formula, displayed in Section VIII, has an overall ***R-Square*** statistic of 0.91.

F. Intertoll Dial Switching Formula

This formula compensates average schedule companies for the cost of tandem switching of interstate access calls. The cost of tandem switching depends primarily on the capacity required to handle interstate usage. The current and the proposed formulas have identical structures, and use the count of Intertoll Dial (ITD) circuits[9] as a measure of tandem capacity. Costs used in this formula were the ITD transport monthly revenue requirements developed in Section VI.D and VI.F. The intertoll circuit counts used in this formula were monthly intertoll circuits projected to the test period as described in Section V.G.

The proposed formula was derived as follows:

$$\text{Cost per Prorated Intertoll Trunk} = \frac{\sum(\text{Sample Weight} \times \text{Intertoll Switching Cost} \times \text{Outlier Weight})}{\sum(\text{Sample Weight} \times \text{Intertoll Circuits} \times \text{Outlier Weight})}$$

[9] Total circuits on the incoming network side of the tandem are prorated among offices subtending the tandem. Only circuits prorated to stand-alone, subtending end offices are eligible for Intertoll settlements. Usage of circuits prorated to other offices is categorized as local switching and, consequently, is included in compensation determined by the Central Office formula.

Outlier Weights were derived using the ratio outlier method described in Section IV.C.2. The resulting formula is displayed in Section VIII.

G. Line Haul Distance Sensitive Formula

ECs provide Cable & Wire Facilities that transport interstate calls from the EC's Central Office to the interexchange carrier's point of connection. The Line Haul Distance Sensitive formula was designed to compensate average schedule companies for the use of these facilities.

Interstate costs of providing this function depend on the length of routes, the circuit count of cable facilities on the routes, and relative interstate usage of the routes.

Current and proposed formulas have an identical structure, which pays an amount per normal circuit mile, an amount per long route circuit mile, and an amount per access minute. The access minute variable reflects capacity required on the routes and relative interstate usage. Access minutes, normal route circuit miles, and long route circuit miles were projected to the test period as described in Section V.C and V.E. Line Haul Distance Sensitive Revenue Requirement was developed as described in Section VI.D and VI.F.

The Interstate Circuit Mile variable combines route miles, circuit counts and relative interstate usage into a single measure of cost. NECA divides the circuit mile variable into normal route circuit miles and long route circuit miles using the threshold of 100 circuit miles per circuit, as described in Section V.E. This calculation reflects the proportionately lower cost incurred by average schedule companies with long, low cost routes. By sharing capacity on networks with very high capacity, these companies achieve significant cost economies, resulting in costs well below average.

Study areas were divided into two groups: those with only normal route circuit miles, and those with both normal route and long route circuit miles.

The Line Haul Distance Sensitive settlement formula depends on four parameters:

- Coefficients of access minutes (b) and of normal route circuit miles (a_1), derived by regression;
- **A** long route threshold (K) derived by network analysis;
- **A** coefficient of long route circuit miles (a_2) calculated using coefficient $\mathbf{a_1}$ and the Long Route Relative Cost Ratio.

To quantify the cost differential between normal and long routes, NECA developed the Long Route Relative Cost Ratio by the following three steps.

First, data from study areas with only normal route circuit miles were used in a linear regression model to determine a preliminary cost per normal route circuit mile. The dependent variable in the regression model was Distance Sensitive Revenue Requirement per Interstate Circuit Mile. The independent variable was Access Minutes per Interstate Circuit Mile. Outliers were accommodated as described in Section IV.C. The following model was derived

Distance Sensitive Revenue Requirement Per Circuit Mile =
0.518130 + *(0.002828 x* ***Access Minutes per Interstate Circuit Mile)***

The regression model had an ***R-Square*** statistic of ***0.78,*** and ***F-statistic*** value **of** 430.07. The ***t-statistics*** for the intercept and the coefficient of Access Minutes per Interstate Circuit Mile were 5.75

and 20.74, respectively. The intercept coefficient of 0.518130 represents the incremental cost per normal route circuit mile.

Second, NECA obtained cost data from the network companies used by most average schedule companies to determine the line haul cost of circuits provided over long route facilities. Lease data included the monthly amount paid by the average schedule company, the number of circuits provided under contract, and route mile information. Circuit miles were calculated as the number of circuits acquired under contract, multiplied by the route miles associated with the routing of those circuits. The monthly cost per circuit mile for these facilities was the monthly amount paid divided by the total number of circuit miles. Monthly cost and circuit mile data for fifty-four average schedule study areas that use long route facilities are displayed in Appendix I. The overall line haul average lease cost per circuit mile for long route facilities was developed as follows:

$$\textit{Average Cost per Long Route Circuit Mile} = \frac{\sum(\textit{Study Area Monthly Cost for Long Route Facilities})}{\sum(\textit{Study Area Circuit Miles for Long Route Facilities})}$$

$$= \frac{\$71{,}291}{1{,}583{,}279} = \mathbf{\$0.0450}$$

Finally, the Long Route Relative Cost Ratio (LRRCR) of 0.086851 was developed by dividing the long route cost of 0.0450 by the preliminary normal route cost of 0.518130. NECA therefore estimated the ratio of long route cost to normal route cost to be 0.086851.

Next, the LRRCR **was** used to create an Equivalent Circuit Mile variable, representing the composite of both normal route and long route circuit miles.

Equivalent Circuit Miles = Normal Route Circuit Miles + (LRRCR x Long Route Circuit Miles)

The Equivalent Circuit Miles variable was used in a linear regression model developed using all study areas. The dependent variable in the regression model was Distance Sensitive Revenue Requirement per Interstate Circuit Mile. The independent variables of the model were access minutes per interstate circuit mile and Equivalent Circuit Miles per interstate circuit mile. Outliers were accommodated as described in Section IV.C. The following model **was** derived:

Distance Sensitive Revenue Requirement Per Circuit Mile =
(0.511164 x Equivalent Circuit Miles per Interstate Circuit Mile)
+ (0.002850 x Access Minutes per Interstate Circuit Mile)

The regression model had an ***R-Square*** statistic of **0.90,** and ***F-statistic*** value of **707.34.** The ***t-statistics*** for access minutes per interstate circuit mile and **the** coefficient of Relative Circuit Miles were 24.51 and 7.07, respectively.

Finally, a settlement rate for long route circuit miles was developed by multiplying the settlement rate for normal route circuit miles by the LRRCR.

Long Route Circuit Mile Rate = Normal Route Circuit Mile Rate x LRRCR
= 0.511164 x 0.086851
= 0.044395

The resulting combined distance sensitive formula is displayed in Section VIII.

H. Line Haul Nan-Distance Sensitive Formula

This formula compensates companies for interstate transport costs incurred to terminate switched access interexchange trunk facilities on end office switches and on tandem switches. These costs depend on the number of circuits provided and on the type of termination equipment used. The proposed formula has a structure identical to the current formula structure, which was first adopted in July 1997, and pays an amount per interstate switched circuit termination that depends on the study area ratio of circuit terminations per exchange. NECA proposes to continue this structure.

NECA analyzed Line Haul Nan-Distance Sensitive revenue requirement per termination. Costs used in the proposed formula were the Nan-Distance Sensitive (NDS) Transport monthly revenue requirements developed in Section VI.D and VLF. Switched interstate circuit terminations were projected to the test period as described in Section V.F.

In prior years NECA has filed a Non-Distance Sensitive Line Haul model that included a terminations per exchange breakpoint. There continues to be a significant difference between average relative revenue requirement per termination for study areas with terminations per exchange greater than the breakpoint as compared to those with terminations per exchange less than the breakpoint. For this reason, NECA continues to propose a Non-Distance Sensitive Line Haul model that includes a terminations per exchange breakpoint.

NECA determined the best-fitting breakpoint through regression analysis. No other breakpoint produced a better fitting model than the current breakpoint of 122 terminations per exchange. The breakpoint of 122 terminations per exchange also ensured settlements produced by this formula increase monotonically as circuit terminations increase.

A regression model of revenue requirement per termination was fit to the terminations per exchange data. This method computed a two-part formula: part one, a sloping line for relatively low terminations per exchange, and part two, a horizontal line for higher terminations per exchange. These lines were constrained to intersect at 122 terminations per exchange. The parameters of the model were the intercept and slope of the line for study areas with terminations per exchange less than 122, and the intercept of the line for study areas with terminations per exchange greater than 122. The latter parameter was derived by the constraint that the two lines meet at 122 terminations per exchange. The resulting formula, shown in Section VIII, had an ***R-Square*** statistic of 0.10, a *t-statistic* of 23.67 and 11.01 for the intercept and slope of the first segment, respectively.

I. Special Access Formula

The Special Access formula compensates average schedule companies for the cost of providing dedicated Special Access facilities, including local channel mileage, service ordering costs and optional features and functions. As **NECA's** special access tariff includes a cost-based charge for each of the elements, revenues billed according to the tariff are a good measure of special access costs of each company.

In prior years, the special access formula has used a retention ratio variable that is the ratio of a study area's special access revenue requirement to its special access revenues. The proposed formula continues to use such a retention ratio variable to produce an accurate settlement rate. The proposed formula also continues to use a size factor, first introduced in the 2000 Study, to better target settlements to individual study areas.

NECA examined both cost and average schedule data to determine that a relationship exists between retention ratios and revenues per exchange. The revenue per exchange size factor is developed using cost company data and is dependent upon Adjusted Special Access Revenues per Exchange. The formula is made up of this cost company size factor equation and an average schedule Basic Retention Ratio.

1. Development of Cost Company Size Factor

   a. Calculation of Cost Company Revenue Requirements

      NECA retrieved the components needed to calculate cost company revenue requirements from NECA's settlement system, using the average month of the October 2002 view of 2000 data and the authorized rate of return.

   b. Development of Revenues per Exchange

      NECA retrieved access lines and special access revenues from the October 2002 view of 2000 settlements data for use in the calculation of the cost company size factor from cost study areas that reported special access revenues. Special access revenues were adjusted to the authorized rate **of** return using the methods discussed in Section V.H.l, to produce Adjusted Special Access Revenues. Revenues per exchange were calculated as Adjusted Special Access Revenues divided by exchanges.

c. Select Cost Companies Reuresentative of Average Schedule Companies

To ensure that the size factor developed by cost company data is representative of average schedule companies, NECA only used cost companies that were similar to average schedule companies in the calculation **of** the size factor. First, NECA developed a retention ratio for each cost study area by dividing Special Access Revenue Requirement by Adjusted Special Access Revenues. Second, NECA excluded those cost companies that had a retention ratio greater than **20** or had greater than **250,000** access lines.

d. Regression to Determine Cost Company Size Factor

NECA first graphed cost company special access revenues per exchange versus retention ratio and fit a model to the data. The model that fit the data best combines a downward sloping line meeting a horizontal line at **$2,435** revenues per exchange. Using this model, companies with revenues per exchange greater than or equal to **$2,435** would receive settlements based on the retention ratio component of the special access formula only, while companies with less than **$2,435** revenues per exchange would receive settlements based on both the retention ratio and the size factor component. The breakpoint ***of*** **$2,435** was determined by fitting a non-linear regression model to the data.

Once the optimal breakpoint of **$2,435** was determined, NECA developed a regression of retention ratio versus revenues per exchange. The regression was constrained to produce settlement results that increase monotonically as revenues per exchange increase.

Regression analysis produced the coefficient of the slope of the line for study areas with revenues per exchange between 0 and **$2,435.** This coefficient was used to derive the intercept of the sloping line and the level of the horizontal line of the model. All three coefficients were then divided by the intercept of the horizontal line, so that study areas with revenues per exchange greater than **$2,435** have an average size factor of 1.0.

The resulting size factor model is shown below.

If Revenues per Exchange < $2,435 then

Revenue Size Factor = 2.0 − 0.00041I x Revenues per Exchange

If Revenuesper Exchange > = $2,435 then

Revenue Size Factor = 1.0

This cost company size factor formula will be combined with an average retention ratio as discussed in the next section.

2. <u>Development of Average Schedule Retention Ratio</u>

   a. <u>Calculation of Average Retention Ratio</u>

An Average Retention Ratio was calculated using average schedule special access revenue requirements developed in Section VLF and forecast special access revenues developed in Section V.I. The retention ratio determines the proportion of tariff revenues that corresponds to the cost incurred by average schedule companies.

Average Retention Ratio

$$= \frac{\Sigma\,(\text{Sample Wgt} \times \text{Monthly Special Access Revenue Requirement} \times \text{Variance Wgt})}{\Sigma(\text{Sample Wgt} \times \text{Monthly Special Access Revenues} \times \text{Variance Wgt})}$$

$$= \frac{\$1{,}958{,}426}{\$2{,}194{,}434}$$

$$= 0.892452$$

b. Derivation of Basic Retention Ratio

NECA calculated the portion **of** special access revenues represented by the Revenue Size Factor Model. NECA obtained average schedule company special access revenues and exchanges from its settlement system for the October 2002 view **of** July 2002, consistent with the special access revenues data to be used in the study area priceout shown in Appendix E. These special access revenues were adjusted to reflect the authorized rate **of** return using the method discussed in Section V.H. 1, to produce Adjusted Special Access Revenues.

Second, NECA calculated each study area's ratio **of** Adjusted Special Access Revenues per exchange. NECA calculated a Revenue Size Factor for each average schedule study area, using its revenue per exchange value and the Size Factor model.

NECA calculated a Revenue Size Factor Portion **of** revenue requirement ratio. The calculation depends upon the Average Retention Ratio developed in Section VII.I.2.a.

Revenue Size Factor Portion of revenue requirement =

$$1 - \frac{\Sigma(\text{Average Retention Ratio} \times \text{Adjusted Special Access Revenues})}{\Sigma(\text{Average Retention Ratio} \times \text{Revenue Size Factor} \times \text{Adj Sp Acc Revenues})}$$

$$= 1 - \frac{5{,}307{,}996}{5{,}613{,}973}$$

$$= 1 - 0.945497$$

$$= 0.054503$$

The Basic Retention Ratio of **0.843811** was calculated as the Average Retention Ratio reduced **by** the Revenue Size Factor Portion.

Basic Retention Ratio

$$= \text{Average Retention Ratio} \times (1 - \text{Revenue Size Factor Portion})$$

$$= 0.892452 \times (1 - 0.054503)$$

$$= 0.843811$$

Finally, the proposed special access formula continues to employ **a** Tariff Rate Index to reflect current tariff rates.

$$\text{Tariff Rate Index} = \frac{1}{1 + \text{Special Access Relative Tariff Rate Change Since 12/2002}}$$

Exhibit 7.4 displays NECA's method for calculating the Tariff Rate Index.[10] Each

[10] The Tariff Rate Index reflects all Special Access tariff rates offered in NECA's Access Service Tariff, F.C.C. Tariff No. 5 for the period. ***See*** National Exchange Carrier Association, Inc., Tariff F.C.C. No. **5,** Transmittal No. 939, filed June 17, 2002 (2002 Annual Access Tariff Filing). This includes rates for recurring charges, nonrecurring charges and optional features and functions.

time NECA files new Special Access tariff rates, it will use data from that filing to calculate a new Tariff Rate Index according to the method displayed in Exhibit 7.4.

The resulting special access formula shifts settlements from larger study areas to smaller study areas, making a more accurate distribution of settlements to compensate for the costs associated with special access provisioning for companies of all sizes. This proposed formula is displayed in Section VIII.

EXHIBIT 7.4

SPECIAL ACCESS TARIFF RATE INDEX CALCULATION METHOD[11]

A.	Illustrative Traffic Sensitive Pool Test Period Special Access Revenues at December 31,2000 Rates	$200,000,000
B.	Illustrative Traffic Sensitive Pool Test Period Special Access Revenues Proposed in the NECA Tariff Filing	$199,000,000
C.	Illustrative Average Schedule Company, Special Access Tariff Rate Index Effective July 1,2001 [Line A/ Line B]	1.005025

J. Signaling Svstem 7 (SS7) Formulas

The Common Channel Signaling (CCS) network is a packet switched network that allows call control signals and database queries to be transported on dedicated lines separate from the voice network. The Signaling System 7 (SS7) protocol is a set **of** rules that governs the transmission of signaling information over the CCS network. The network is composed of nodes defined as Signal

[11] NECA will recalculate the Tariff Rate Index using data from its tariff filing coincident with the effective date of any special access tariff rate change.

Point (SP), Service Switching Point (SSP), Consolidation Point (CP), Signal Transfer Point (STP) or Service Control Point (SCP). Telephone companies rarely install SP without SSP technology. Therefore, for simplicity the term SSP, as used herein, will refer either to an SP or SSP.

The **SS7** formulas compensate companies for their costs based on counts of SSPs in service. There are two average settlement rates per SSP currently in effect, one rate for each SSP connected to the nationwide signaling network and another rate for each SSP <u>**not**</u> yet connected to the nationwide signaling network.

1. <u>Development **of** Settlement Formula for SSPs with Full Connectivity</u>

The proposed settlement formula for an SSP with full connectivity includes three components that provide cost recovery for the company's capital investment in SSPs and CPs, provisioning of interconnecting data links, and access to the nationwide **SS7** network. These are:

Monthly investment cost:	the interstate return and loadings associated with the company's capital investment in SSPs and CPs.
Monthly CP data link cost:	the interstate portion of the cost of **SS7** signaling links between the SSP and the CP.
Monthly A-link cost:	the interstate portion of charges for **SS7** signal transport and access to STPs in the nationwide SS7 network.

Development of these components is described in the following three sections. The formula calculation incorporating these components is described in Section VII.J.l .d. Supporting data are displayed in Appendix G.

a. Development of Monthly Investment Costs

NECA used investment data described in Section III.H, the monthly investment charge factor developed in this section, and separations factors to determine investment costs related to SS7.

Investment in SSPs and CPs was developed from data reported by the population of average schedule companies that receive SS7 settlements. For SSPs that were reported with incomplete cost data, NECA used the average cost of other SSPs of the same model type. In a few cases, when the carrier did not identify the model type of SSP, NECA used the overall average cost.

These investment data are displayed in Column C of Appendix G as Capital Investment Cost. The Monthly Investment Cost (displayed as Column D in Appendix ***G)*** is the product of the study area capital investment cost and the monthly investment charge factor.

The monthly investment charge factor provides for the return on average net interstate investment, Federal and State Income taxes, interstate accumulated depreciation, interstate depreciation expense, and maintenance and corporate operations expenses. The monthly investment charge factor of 0.015386 was developed as shown in Exhibit 7.5.

In Exhibit 7.5, the average interstate depreciation reserve ratio of 0.470344 is the